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The Impact of Bittern and Gliricidia on the Growth of Chili Plants in Sri Lanka

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Abstract

Due to its unique spiciness, *Capsicum annuum,* Chili is an economically valuable crop in high demand in global and local markets. It belongs to the Solanaceae family. This study investigated the effect of Bittern and *Gliricidia sepium,* Gliricidia plant leaf extract pulp as a complete organic multi-nutrient low-cost fertilizer. Vermi wash and Albert's Solution were used as inorganic and organic treatments to analyze the effect on Chili plant growth and development. This experiment observed suitable fertilizer treatment for the bittern solution to complete nitrogen deficiency and generate complete organic fertilizer. This study employed a Randomized Complete Block Design (RCBD) with 13 Treatment groups and 1 controlled group. Treatments were carried out for 10 weeks. Chili plant growth was analyzed using data for vegetative growth parameters, height, stem width, leaf count, and leaf area. Bittern 25% complex with *Gliricidia sepium* leaf extract pulp treated plants were the first initiating branching, second tallest plants (25.5 cm) with secondary branching was observed. Bittern 25%, *Gliricidia sepium* leaf extract pulp with Albert's solution also significantly showed the highest results on growth, tallest plants (28.5cm), the highest number of leaves, Branching & secondary branching. Analyzing results identified suitable bittern concentration with organic complex for optimal plant growth. Pot plant treatments should increase with growth stages to prevent nutrient deficiencies and optimize growth and development. Statistical analysis used One-way ANOVA and Microsoft Excel.

Keywords: Capsicum annuum; Organic fertilizer; Bittern; Gliricidia sepium; Vegetative growth parameters

2. Introduction

Chili plants, a part of the Capsicum genus, have been a subject of scientific research and agricultural innovation for centuries. Their unique chemical composition, including spicy substances, has contributed to their culinary appeal and has significant implications for various sectors such as agriculture, medicine, and food science. In Sri Lanka, bittern solution, a byproduct of salt production, has gained attention as an organic fertilizer alternative to chemical fertilizers. However, the bittern solution lacks nitrogen and phosphorous, essential for plant growth and yield (Hayano-Kanashiro, 2016) (Hewage, 2022).

Gliricidia sepium, a plant rich in nitrogen and plant growing medium, can be introduced to replace the nutrient deficiencies in bittern. This leguminous tree improves soil fertility by increasing nitrogen availability, making it a great choice for agroforestry systems. Its rapid growth rate and nitrogen-fixing capacity make it a great choice for agroforestry systems,

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where it can improve soil fertility and supply feed. This research aims to introduce a complete organic fertilizer for Chili plant growth and development using bittern and *Gliricidia sepium* (Alamu, 2023).

The objective of the study is to evaluate the effects of various bittern concentrations on Chili plant growth by examining characteristics such as plant height, biomass, leaf area, and root development. The research gap highlights the need for further investigation into the development of *Gliricidia sepium* as a viable organic fertilizer. Additionally, more research is required to assess the parameters, final yield, costs, benefits, and overall agricultural impact of using a complex fertilizer composed of Bittern and *Gliricidia sepium*.-Developing an indigenous source as a growth medium and organic fertilizer is important for both agricultural and strategic reasons. The study aims to strengthen the agricultural industry, Chili agriculture, and improve global food safety.

3. Materials and Methods

3.1 Plant Material & Growth Medium

The study, conducted at the Sri Lanka Institute of Information Technology (SLIIT), examined the impact of industrial wastewater bittern. Table 1 shows the chemical composition of bittern and *Gliricidia sepium* as a complete nutrient supplement for chili plant growth and development.

Table 1. Chemical Composition of Leftover Brine Solution

Calcium Sulfate (CaSO4)	0.4-0.6%
Magnesium Chloride (MgCl2)	0.2-0.4%
Potassium Chloride (KCl)	0.05-0.1%
Sodium Sulfate (Na2SO4)	0.05-0.1%
Calcium Chloride (CaCl2)	0.02-0.03%
Other impurities <0.01%	<0.01%

A Negligible amount of NaCl is present.

The chili seeds, specifically the KA2 variety, were sourced from the Ministry of Agriculture's Department of Agriculture, Government Seeds & Plant Material Center in Colombo. The KA2 variety, a well-known open-pollinated chili with desirable agronomic features and high yield potential, was chosen for the experiment. Additionally, the study investigated the use of coir dust as a growth medium. Two types of coir dust were utilized: coir pellets for seed germination and coir dust for seedling transplantation. The pH level of the coir was tested before sowing the chili seeds in coir pellets and transplanting them into coir dust. The results confirmed that the coir's pH levels were slightly acidic, suggesting the potential of using coir dust as a nutrient-free growth medium for chili plant growth and development.

3.2 Experimental Design

The chili plants were obtained from KA2 seeds, which were seeded in 30mm jiffy coir pellets. The seeds were soaked in warm water, 130°F (54°C) to initiate germination and then placed in coir trays, covered with polythene to create a propagator. After germination, the trays were moved to sunny, warm areas in a plant house. Water treatment and Albert's solution were applied to support growth. After three weeks, the plants were transplanted into polythene pots and placed in a greenhouse using the Randomized Complete Block Design (RCBD) method.

3.3 Fertilizer Preparation & Treatment

The experiment aimed to study the effects of Bittern and *Gliricidia sepium* as a complex organic treatment for chili plant growth and development. Both organic and inorganic fertilizer treatments were used, with Albert's solution as the control. The goal was to identify the optimal brine concentration for chili plant growth, which was determined to be between 20% and 50%. The experiment utilized 25% and 50% Bittern, with plant labeling for clarity. There were six treatment groups (T1-T6), each with 25% and 50% Bittern treatment groups, totaling 14 groups including the control as shown in Table 2.

The Bittern solution was prepared using industrial

wastewater from Maha Lewaya, Sri Lanka, which contains significant amounts of calcium, magnesium, potassium ions, and inorganic minerals. Water was used to prepare the solution to minimize the chlorine supply to the growth medium. *Gliricidia sepium* plant material was added as leaf pulp for the T2, T4, and T6 treatment groups. Vermi Wash and Albert's solution inorganic fertilizers were prepared according to the manufacturer's guidelines. The experiment aimed to compare the effectiveness of these treatments on chili plant growth and development.

Table 2. Treatment combinations used for each group

Treatment Group	Fertilizer Treatment
Control	Albert solution – 2g Albert + 1L water
T1a	Bittern 25%
T1b	Bittern 50%
T2a	Bittern 25% + Gliricidia leaf pulp 10g
T2b	Bittern 50%+ Gliricidia leaf pulp 10g
T3a	Bittern 25% + Albert solution75%
T3b	Bittern 50% + Albert solution 50%
T4a	Bittern 25% + Gliricidia leaf pulp 10g + Albert solution 25%
T4b	Bittern 50% + Gliricidia leaf pulp 10g + Albert solution 50%
T5a	Bittern 25% + Vermi-wash 25%
T5b	Bittern 50% + Vermi wash 50%
T6a	Bittern 25% + Gliricidia leaf pulp 10g + Vermi-wash 25%
T6b	Bittern 50% + Gliricidia leaf pulp 10g + Vermi-wash 50%
T6C	Bittern 25% + Gliricidia leaf pulp 10g + Vermi-wash 50%

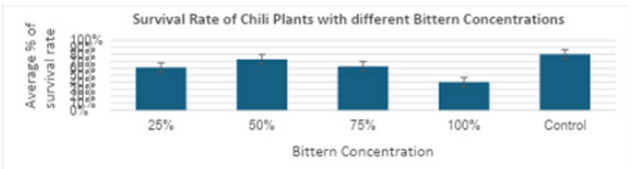
3.4 Data Collection & Data Analysis

The study monitored the growth and development of Chili plants over two months. Data collected included plant height, leaf number, branch count, leaf area, and stem width. Plant height was measured using a 30 cm ruler, while stem width was assessed with a vernier caliper. Branching and leaf counts were determined by averaging measurements across treatments. Leaf area was calculated by measuring the length and width of three leaves from each plant. The weekly data were organized in Microsoft Excel, where average values were computed. Data analysis was performed using Microsoft Excel's data analysis functions, including one-way ANOVA, to calculate mean values and standard errors.

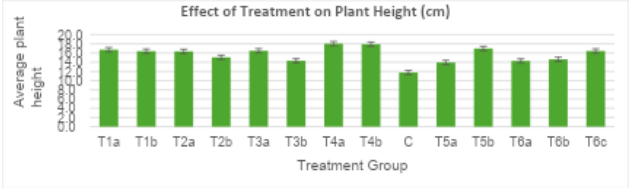
4. Results and Discussion

4.1 Impact of Experimental Fertilizer Treatments on Different *Capsicum annuum* Plant Vegetative Growth Parameters.

The plants were treated with Albert's solution for approximately four weeks before the start of the expected treatments. According to previous studies, the optimal bittern concentration for the Chili plant is seen in Figure 1A. The results indicated that the T1-T4 treatment group, which included Bittern, *Gliricidia sepium* plant pulp, and Albert's solution, exhibited significant growth in both plant height and leaf number per plant as seen in Figure 1B and Figure 1D. In contrast, the control group did not show significant growth, suggesting that additional nutrients are necessary for optimal plant development. The highest plant height, recorded at 35 cm in the T4 group, highlighted the impact of nitrogen and other nutrients on plant growth. The stem width growth parameter demonstrated that both Bittern and *Gliricidia* treatments were effective. Additionally, the average number of leaves indicated that Bittern and *Gliricidia* treatments were highly efficient for enhancing chili plant growth. The branching growth parameter as seen in Figure 1E, also showed improvements with the Bittern and *Gliricidia* treatments. In summary, treatment results revealed that while Bittern alone was beneficial, the combined Bittern and *Gliricidia* treatment provided more substantial insights into chili plant growth and development.



A



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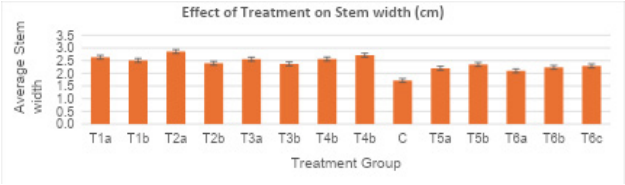

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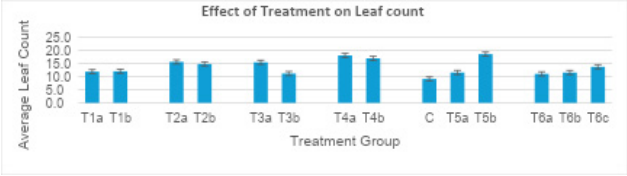

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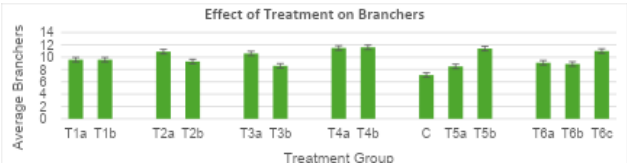

E

Figure 1. Experimental fertilizer Treatment Impact on vegetative growth parameters; A) Suitable bittern concentration identification and B) Plant height with different treatment groups over time. ($P<0.05$) C) Plant Stem width with different treatment groups over time. ($P<0.05$) D) Plant number of leaves is counted with different treatment groups over time. ($P<0.05$) E) Plant number of Branch count with different treatment groups over time ($P<0.05$).

4.2 Discussion

Chili, a tropical fruit known for its strong flavor, is commonly used in Asian cuisine and can be classified as a vegetable, fruit, or herb. *Capsicum annum*, a widely cultivated plant, has been tested with a new organic fertilizer, *bittern*, to enhance its growth. While chemical fertilizers provide short-term solutions, their prolonged use in developing countries like Sri Lanka has led to health issues among farmers. Therefore, introducing low-cost, nutrient-rich organic fertilizers is crucial (Hayano-Kanashiro, 2016).

This study aimed to develop a comprehensive organic fertilizer using *bittern* and *Gliricidia sepium* to support Chili plant growth. Results showed that the T2 treatment, a *bittern* and *Gliricidia* complex, had a notable positive impact on growth parameters. However, it also affected the timing of the first fruit initiation and secondary branching flower initiation, influencing the overall yield.

The optimal concentration of *bittern* was found to be between 25% and 50%. Specifically, 25% of *bittern*-treated plants demonstrated significant reproductive growth, particularly in combination with *Gliricidia sepium*. This research focuses on Chili cultivation in Sri Lanka and seeks to introduce an organic fertilizer with commercial potential.

Future studies should assess the cost-effectiveness of replacing inorganic fertilizers with this organic complex treatment and evaluate its impact on yield within a specified timeframe. It is also essential to analyze the chemical composition and profiles of *bittern* and *Gliricidia sepium*, ensuring that their efficacy and shelf life are maintained. Further research could explore microbiological analyses related to plant growth and disease resistance. This study has successfully demonstrated the potential of utilizing *bittern*, a byproduct of industrial desalination, as a fertilizer in combination with the well-known nitrogen source, *Gliricidia sepium*.

Conclusion

This study thoroughly evaluated the impact of *bittern* and *Gliricidia sepium* on the growth and development of Chili plants. Notable vegetative growth was recorded throughout the study period. Results demonstrated that Chili plants receiving *bittern* and *Gliricidia sepium* fertilizer exhibited substantial improvements in height, leaf area, number of leaves, and stem width. The most effective treatment was found to be the 25% *bittern* combined with *Gliricidia sepium*. *Gliricidia sepium* effectively addressed the nitrogen deficiency of *bittern*, creating a well-rounded fertilizer solution. One-way ANOVA statistical analysis revealed highly significant results ($P<0.05$), confirming the substantial impact of *bittern* and *Gliricidia sepium* on Chili plant growth,

flowering, and fruiting. These findings highlight the effectiveness of this low-cost, nutrient-rich organic fertilizer in enhancing Chili cultivation.

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